A RISK WORTH TAKING?

AN EXAMINATION OF DRIVER HAND POSITION AS A RISK TAKING BEHAVIOUR

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By

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Table of Contents

Acknowledgements ii

List of Figures v

List of Tables v

Abstract vi

Introduction 6

Why Examining Risk Taking is Important 6

Driver Characteristics associated with Risk Taking 2

Theories Relating to Risk Taking 3

Risk Taking and Accident Likelihood 5

Hand Position and Risk Taking 7

Study 1: Reliability of a Hand Position Measure 11

Method 11

Drivers Observed 11

Site selection 11

Procedure 12

Results 13

Inter-rater reliability 13

Contextual Reliability 13

Conclusion 15

Study 2: Hand Position, Speed, Headway and Gender 16

Method 18

Drivers Observed 18

Site selection 18

Procedure 18

Results 19

Conclusion 22

Study 3: Psychological Predictors of Hand Position 24
Method 27
Drivers Observed 27
Site selection 27
Procedure 27
Questionnaire 29
Results 31
Conclusion 35
Discussion 36
Limitations 42
Future Research 43
Conclusion 45
References 46
Appendices ..... **Error! Bookmark not defined.**
Appendix A: Driver Behaviour Questionnaire 51

List of Figures

Figure 1. Mean speeds in kilometers per hour of driver with 0, 1 and 2 hands on the top half of the steering wheel.....18

Figure 2. Mean reciprocal headway in seconds of drivers with 0, 1 and 2 hands on the top half of the steering wheel.....19

List of Tables

Table 1. Means and Standard Deviations of hand positions of North and South Bound Traffic.....13

Table 2. Means and Standard Deviations of Hand Positions of Traffic on the 27 November 2006 and 28 November 2006.....13

Table 3. Means and Standard Deviations of male and female hand positions.....20

Table 4. Correlations of psychological variables, self reported hand position and observed hand position where observed gender matched the survey gender.....31

Table 5. Correlations of psychological variables and self reported hand position with all survey data included.....32

Table 6. Regression of psychological variables on self report hand position.....33

Abstract

It has been well established that risk taking is a contributing factor to the incidence of vehicle crashes. Research by Walton and Thomas (2005) showed that only 25 percent of drivers drive with two hands on the top half of the steering wheel. The research examines driver hand position as a risk taking behaviour in three studies. Study 1 shows driver hand position as measured by Walton and Thomas (2005) has good inter-rater reliability and demonstrates both temporal and contextual reliability. Study 2 used an Infra Red Traffic Logger to show that driver hand position is related to speeding behaviour and headway (other measures of risk taking). A Mantel-Haenszel common odds ratio estimate revealed that females are 2.87 times more likely than males to place two hands rather than one hands on the top half of the steering wheel. In Study 3, a questionnaire sent to 500 drivers measured self reported hand positions and four psychological variables; risk taking, hand position beliefs, confidence and optimism bias. Regression analysis showed risk taking, hand position beliefs and optimism bias significantly predict self report hand position. It is concluded hand position is related to risk taking behaviour and is therefore a reliable intermediate measure of driving behaviour relating to accidents.

Introduction

Why Examining Risk Taking is Important

Official statistics from the New Zealand Ministry of Transport (MOT) indicate that in 2005, 14 451 New Zealand road users were injured or killed in a motor vehicle accident. Improving road safety is a high priority in New Zealand and the MOT has implemented a "Road safety to 2010" strategy. Key areas that were identified for action include reducing risk taking

behaviours such as reducing speed, combating drink-driving and encouraging the use of seatbelts. Also included in the strategy is provision for designing new and specific targeted education initiatives.

Recognition of individual differences has led to an increase in studies examining risk taking behaviours by drivers. Individual differences result in certain drivers engaging in more risk taking behaviours than others. Driving errors leading to fatal crashes do not occur at random, but are associated with specific driver characteristics (Perneger & Smith, 1991). Perneger and Smith found that alcohol levels, seatbelt use, driving without a valid drivers licence and having had a crash in the last year, are associated with fatal crash involvement. The link between risk taking behaviours and crash related injury has been extensively studied. There seems to be general consensus in the literature that risk taking behaviour is a contributing factor in crash involvement (e.g. Bell, Amoroso, Yore, Smith, & Jones, 2000; Fahrenkrug & Rehm, 1994). Using logistic regression analysis, Turner and McClure (2004) identify that, after adjusting for demographic variables, number of years driving and total distance driven per week, high risk acceptance was associated with an eightfold increased risk of having a crash that resulted in serious injury.

Driver Characteristics associated with Risk Taking

Driver characteristics such as age and sex differences have been associated with risk taking behaviour. Storie (1977) offered an insight into sex differences in risk taking examining 2654 car drivers involved in 2036 accidents over a four-year period. Storie found that, although culpability was equal for both males and females, female accidents were primarily attributable to perceptual and judgemental errors whereas male accidents were primarily attributable to unwarranted risk taking, including speeding and drinking. Males have been found to drive with faster speeds (Baxter et al.,1990; Evans & Wasielewski, 1982a, 1983;Wasielewski, 1984), drive with shorter headways (the relative position of a vehicle

behind another vehicle) (Evans & Wasielewski, 1982a; Wasielewski, 1984) and drive more recklessly (French et al., 1993; Reason et al., 1990; Rolls et al., 1991; West et al., 1992). In a meta-analysis, Byrnes et al. (1999) showed that males took more risks than females in 14 out of 16 risk taking behaviours examined.

A number of studies have identified age differences in risk taking behaviour. Statistics from the MOT (2005) indicate that drivers between the ages 15-19 make up the largest group killed on New Zealand roads (20.5%) followed by 20-24 year age group (12.3%). It might be argued that younger drivers' high accident likelihood could be attributable to lack of experience and therefore having less skill than older drivers. However, recent research by Clarke, Ward and Truman (2005) suggests that younger drivers, if anything, have higher than average control skill but this is offset by their risk taking decisions. Younger drivers have been shown to drive with faster speeds (Baxter et al., 1990; Fancher et al., 1998; Quimby et al., 1999 a,b), shorter headways (Dingus et al., 1997; Evans & Wasielewski, 1982a; Fancher etal., 1998; Wasielewski, 1984), and drive more recklessly (Baxter et al, 1990; French et al., 1993; Reason et al., 1990; West et al., 1992).

Theories Relating to Risk Taking

A number of theories have been developed to explain risk taking behaviour, many of which do not appear to be mutually exclusive. Sensation seeking has often been used as an explanation for risk taking behaviour. Zuckerman (1994, p. 27) defines sensation seeking as "a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences and the willingness to take physical, social, legal and financial risks for the sake of such experiences." Zuckerman believes that monoamine transmitters such as dopamine, norepinephrine and serotonin underlie the trait of sensation seeking. Jonah (1997) reviewed 40 studies examining the relationship between sensation seeking and risky driving finding that only four did not show a significant positive relationship between the two. Sensation

seeking has also been associated with high risk activities such as potentially dangerous experiments, risky sports vocations, criminal activities, sexual behaviour, smoking, heavy drinking and drug use (Zuckerman, 1979a; 1994). High sensation seekers tend to have lower appraisals of risk and experience less anxiety in risky situations than low sensation seekers (Horvath & Zuckerman, 1993, Zuckerman, 1979b). Zuckerman (1983) notes that sensation seeking peaks in adolescence and steadily declines with age thereafter, a finding that Palamara and Stevenson (2003) note is consistent with the developmental patterns of young driver aberrant behaviour.

Wilde (1988, 1997) outlines that the level of risky behaviour an individual decides to engage in depends on four utility factors: the expected benefits of the risky behaviour alternatives, the expected costs of risky behaviour alternatives, the expected benefit of safe behaviour alternatives and the expected costs of safe behaviour alternatives. Wilde notes that risk taking will be greatest when the expected benefits of risky behaviour and the expected costs of safe behaviour are highest, and the expected cost of risk taking behaviour and the expected benefit of safe behaviour are lowest. The actual level of risk taking individuals' engage in is where their net benefit is maximised. Wilde refers to this as the target level of risk. Wilde's Risk Homeostasis Theory (1982, 1988) is a theory of risk taking based on the arguments made by early traffic researchers, Gibson and Crooks (1938) that drivers react to environmental changes. Gibson and Crooks argue that driving is a perceptual task whereby in a driver's course, obstacles are seen and must be avoided to prevent having an accident. Risk homeostasis theory posits that drivers constantly monitor the risk in the environment and compare it to the risk they are willing to accept (target risk). Drivers then alter their behaviour in an attempt to eliminate any discrepancy between the risk they perceive and the risk they are willing to accept. Initially the theory was presented stating that accident risk remained constant at a societal level. Rothengatter (2002) notes that conflicting findings and

a lot of opposition meant this postulation was difficult to maintain. As a result the theory was later adapted to explain behaviour at an individual level. The theory suggests that individuals maintain a constant level of risk. In situations involving low risk, individuals will increase their risk taking behaviour to compensate and return to their target level of risk. The theory pessimistically suggests safety interventions are futile as individuals simply alter their behaviour to negate any reduction in risk achieved by the intervention.

Behaviour change has been demonstrated by researchers such as Sagberg et al. (1997) who observed 213 taxis in Oslo and found those equipped with anti-locking breaking systems (ASB) had significantly shorter headway times of 2.2 seconds compared to 2.8 second headway times of those without ASB breaking. Sagberg et al. (1997) suggest that the safety benefits of associated with ASB breaking are negated by increased risk taking from drivers.

Although behaviour change has been demonstrated, McKenna (1987) argues that it does not always occur and when it does, it does not always completely negate the safety intervention. McKenna (1987) cites a study by Rumar et al. (1976) who assessed drivers' speed when using studded tyres designed to give extra grip in icy conditions. Rumar et al. found that those who used studded tyres drove faster but still had a larger safety margin than those who drove without the tyres. Rothengatter (2002, p251) notes, "This notion has been debated at length and the consensus is now that although drivers tend to adapt their behaviour to improved road and vehicle engineering design, they do not in all circumstances adapt their behaviour such that risk remains constant". Importantly, behavioural compensation suggests that drivers will take less risk in high risk environments than low risk environments.

Risk Taking and Accident Likelihood

To understand the link between risk taking and crash involvement it is essential to identify behaviours that are associated with risk taking. Once a driving behaviour has shown to be

associated with risk taking, researchers can then attempt to quantify its relationship with objective risk. Doing so indicates how much risk an individual is placing himself at by engaging in the associated behaviour. For example, a number of early studies identified the link between risk taking and driving under the influence of alcohol (e.g. Farrow, 1986) although the question arises as to how much more risk one puts oneself in by drink driving?

This led researchers such as Zador (1991) to quantify the relationship between drink driving and driver crash risk. Zador estimated that, for every 0.02 percent increase in the blood alcohol concentration (BAC) of drivers with a non-zero BAC, the risk of being involved in a fatal crash nearly doubles. Hence, once a risk taking behaviour is identified, research can then attempt to quantify the relationship of the behaviour with relative risk of an accident.

Risk taking behaviours that have been shown to be associated with crash involvement include speeding (e.g. Aarts & Van Schagen, 2006), driving with short headways (Broughton, Switzer & Scott, 2007) and drink driving (Mayhew, Donelson, Beirness & Simpson, 1986). Seatbelt use (a risk taking behaviour) has also been linked to potential injury (e.g. Evans, 1991).

New Zealand's motoring authorities acknowledge the importance of targeting risk taking behaviours. The MOT currently has a major advertising and enforcement campaign directly targeting risk taking behaviours to help deliver the 'Road to Safety 2010' strategy. The campaign targets four major problem areas including speeding, drink driving, giving way at intersections and seatbelt use. Awareness is made via television advertising, outdoor advertising (e.g. billboards) and print advertising. Behaviours such as short headways are also targeted to encourage appropriate following distances. Because risk taking is a significant contributor to crash involvement, much time and effort has been put towards changing individuals' attitudes and behaviours surrounding risk taking. A question then arises as to why the literature and research authorities have overlooked examining an area of risk taking

with regard to one of the few behaviours that is directly responsible for the control of the vehicle: hand position on the steering wheel.

Hand Position and Risk Taking

The official New Zealand rode code's recommended hand position is "10-2" (Land and Transport Safety Authority, 1999). This is derived from the analogy of steering wheel hand placement to clock face figures. Kline (2001) notes that placing the left hand between 9 and 10 o' clock and the right hand between 2 and 3 o'clock allows for balanced shoulder strength. In a study of truck drivers, Sanders (1981) showed that when drivers experienced the peak torque of a tyre blowout, eight percent who adopted a 9-3 hand position would lose control of the vehicle, whilst 16 percent who adopted a 1-7 hand position would lose control of the vehicle.

The MOT (2005) indicate that loss of control of the vehicle is the third highest factor likely to be contributing to fatal accidents (controlling for factors such as "too fast for the conditions" and "alcohol and drugs") and the second highest factor probably contributing to injury crashes, equal with "did not see other party". Statistics such as these might not seem surprising considering the findings of Walton and Thomas (2005) who have shown that on average only 25 percent of drivers place two hands on the top half of the steering wheel when driving. This finding raises the question as to which drivers are placing no hands on the top half of the wheel.

Walton and Thomas (2005) devised a measure of driver hand position, observing the number of hands on the top half of the steering wheel. Drivers were classed as having two hands (two hands visible from 9 to 3 o'clock), one hand (one hand from 9 to 3 o'clock) or zero hands (no hands visible between 9 and 3 o'clock). Walton and Thomas (2005) identified that at an aggregate level, drivers alter their hand position as a function of the complexity of the

environment, for example showing that on average, drivers tend to place more hands on the top half of the wheel in a 100km/h speed zone than in a 50 km/h zone.

Similarly, following the findings of Wasielewski and Evans (1985), which showed that risk taking (as expressed by seatbelt use, shorter headway and faster speeds) increases with vehicle mass, Thomas and Walton (2007) found hand position also changes as a function of the driving context. Car drivers were 1.55 times more likely to place two hands instead of one hand on the top half of the steering wheel compared to SUV drivers. After observing that driver hand position changes as a function of the complexity of the environment and driving context, Walton and Thomas (2005) and Thomas and Walton (2007) suggested that changes in driver hand position indicate changes in the risk drivers perceive in the environment.

Walton and Thomas (2005) suggest that when drivers perceive risk in the environment, they respond by looking to gain more control of the vehicle by adjusting their hand position. Importantly, Walton and Thomas (2005) claim that driver hand position offers an insight into the risk drivers perceive across samples of drivers (aggregate hand position), although make no claim as to individual differences that may influence driver hand position. It is assumed that across samples, the distribution of individual differences for the groups would be the same so do not need to be statistically controlled for. Hence, across samples, Walton and Thomas and Thomas and Walton (2005) assume that differences in hand positions are due to changes in the perception of the environment.

At an individual level, the amount of risk a driver is prepared to accept (their level of risk taking) may influence their hand position. Drivers who are willing to accept higher levels of risk such as driving at high speeds, driving without a seatbelt or driving under the influence of alcohol may be the same drivers who driving with no hands on the top half of the wheel. As such, hand position as a risk taking behaviour could offer an explanation for Walton and Thomas (2005) and Thomas and Walton's (2007) findings at an individual level. The

behavioural compensation framework posits that drivers take fewer risks in high risk situations than in low risk situations. Following this, the finding that hand position varies across driving contexts may be explained at an individual level whereby drivers who perceive more risk in an environment respond by taking fewer risks i.e. adopting a hand position that affords more control.

If driver hand position is related to risk taking, then hand positions relationship to objective risk could be investigated too assess how much risk an individual is placing themselves in by the hand position they adopt. If hand position is related to objective risk, drivers who are taking risks in other driving scenarios would be the same drivers who are taking risks with their hand position placement. If this is the case it may be possible to alter driver behaviour such that they take fewer risks by driving with both hands on the top half of the wheel. Safety campaigns could target hand position in the same manner as speeding, drink driving, following distance and seatbelt use.

Three studies are presented to examine the overall research question; whether driver hand position is related to individual risk taking. They look to establish whether hand position can be reliably measured, whether hand position relates to other risk taking behaviours, namely headway and speed and assess whether a direct link exists between hand position on the steering wheel and driver risk taking.

Study 1: Reliability of a Hand Position Measure

If hand position is to be examined as a risk taking behaviour, it must be measured reliably. Reliability refers to the consistency or stability of a measure (Muchinsky, 2003). A measure of driver hand position must have good inter-rater reliability as hand position varies between individuals and observers are required to make judgements with regard to hand position placement. It is hypothesised that the measure of hand position adopted by Walton and Thomas (2005) will have good inter-rater reliability.

As noted, hand position as a risk taking behaviour may offer an insight into the findings that hand position varies as a function of the environment. However, hand position has not been demonstrated to be contextually or temporally reliable. Following the arguments of Walton and Thomas (2005) and the concept of behaviour compensation, drivers should perceive and take similar amounts of risk in similar conditions across time. It is hypothesised that observations of driver hand position will remain constant when two separate observations are made in similar situations. It is further hypothesised that driver hand position will remain constant when two separate observations are made under the same condition across time.

Method

Drivers Observed

200 drivers in the area of Lower Hutt, New Zealand were observed to assess the inter-rater reliability of the hands-on measure. 668 drivers were observed to assess the contextual and temporal reliability of the hands-on measure.

Site selection

Two sites were selected to assess the inter-rater reliability of the hand on measure. 100 observations were made in a 100km/h zone on State Highway 2, Lower Hutt. A further 100

observations were made in a 50km/h zone on Cambridge Terrace, Lower Hutt. The temporal and contextual reliability of the hands on measure was assessed on State highway 2 between Lower Hutt and Upper Hutt.

Procedure

Inter-rater reliability

Two observers stood side by side on the side of the road. One observer randomly called out a selected oncoming car and both observers wrote down the hand position configuration they observed. Hand position configurations followed the method outlined by Walton and Thomas (2005) where the number of hands in the target zone on the top half of the steering wheel (between 3 o'clock and 9 o'clock on an analogue clock face) was recorded as either zero, one or two. Once 100 cars had been recorded at each site the level of agreement was assessed. Cohen (1960) noted that when assessing the inter-rater reliability of categorical variables, a certain expected proportion of observer agreement is entirely attributable to chance. If two raters were to simply blind guess which category a driver belonged to with no knowledge of base rates, there would by chance be 33 percent agreement. Hence, when assessing the inter-rater reliability of the hands on measure, in addition to a standard measure of agreement, a Cohen's kappa which controls for this chance was calculated.

Temporal and Contextual Reliability

To assess the temporal reliability of the hands on measure, drivers' hand positions were compared at the same location on two separate days; ensuring observations were made at the same time (similar traffic flow) in clear weather conditions. Specifically, hand positions were observed between 2-3pm on state highway 2 (100km/h) between Lower and Upper Hutt. 324 observations were made on the 27/11/06 and 344 observations were made on the 28/11/06.

To assess the contextual reliability of the hands on measure, two observers simultaneously and independently measured drivers' hand positions in two situations which were deemed to be similar, namely north and southbound traffic on the same stretch of State Highway 2, Lower Hutt. 331 observations were made on traffic travelling northbound and 337 observations were made on southbound traffic.

Results

Inter-rater reliability

In the 50 km/h zone there was 95% agreement with a Cohen's kappa of 0.90. In the 100km/h zone there was 93% agreement with a Cohen's kappa of 0.88. A general rule of thumb is that a kappa of 0.40 to 0.59 is moderate inter-rater reliability, 0.60 to 0.79 substantial, and 0.80 outstanding (Landis & Koch, 1977).

Contextual Reliability

Table 1 outlines the frequency of hand position configurations adopted under the northbound and southbound conditions. A Chi-square indicated that hand position was independent of direction χ^2 (2,668) = 0.441, ns. This suggests that the proportion of drivers who adopted a zero, one and two hand position configuration was the same in the northbound and southbound conditions.

Table 1.

Cross tabulation and chi-square analysis of the number of drivers observed placing zero, one and two hands on the top half of the wheel for North and South bound traffic.

			Traffic Direction		
			North Bound	South Bound	Total
Hand Position	no hands	Count	73	76	149
		Expected Count	73.8	75.2	149.0
		% within Traffic Direction	22.1%	22.6%	22.3%
		Adjusted Residual	-.2	.2	
	one hand	Count	147	156	303
		Expected Count	150.1	152.9	303.0
		% within Traffic Direction	44.4%	46.3%	45.4%
		Adjusted Residual	-.5	.5	
	two hands	Count	111	105	216
		Expected Count	107.0	109.0	216.0
		% within Traffic Direction	33.5%	31.2%	32.3%
		Adjusted Residual	.7	-.7	
Total		Count	331	337	668
		Expected Count	331.0	337.0	668.0
		% within Traffic Direction	100.0%	100.0%	100.0%

Table 2 outlines the frequency of hand position configurations adopted over the 27th of November and 28th of December 2006. A Chi-square further indicates that hand position was independent of day χ^2 (2,668) = 1.264, ns. This suggests that the proportion of drivers who placed zero, one and two hands on the top half of the wheel was the same on the 27th of November and 28th of November 2006.

Table 2.

Cross tabulation and chi-square analysis of the number of drivers observed placing zero, one and two hands on the top half of the wheel over the 27th and 28th of November 2006.

			Day		
			27/11	28/11	Total
Hand Position	no hands	Count	74	75	149
		Expected Count	72.3	76.7	149.0
		% within Day	22.8%	21.8%	22.3%
		Adjusted Residual	.3	-.3	
	one hand	Count	152	151	303
		Expected Count	147.0	156.0	303.0
		% within Day	46.9%	43.9%	45.4%
		Adjusted Residual	.8	-.8	
	two hands	Count	98	118	216
		Expected Count	104.8	111.2	216.0
		% within Day	30.2%	34.3%	32.3%
		Adjusted Residual	-1.1	1.1	
Total		Count	324	344	668
		Expected Count	324.0	344.0	668.0
		% within Day	100.0%	100.0%	100.0%

Conclusion

Driver hand position as measured by Walton and Thomas (2005) appears to have good inter-rater reliability and hence can be reliably observed. This has important implications for future research on driver hand position. The measure also appears to demonstrate temporal and contextual reliability. This suggests that hand position as a risk taking behaviour could offer a viable explanation to the findings of Walton and Thomas (2005) and Thomas and Walton (2007). Drivers may alter their hand position across contexts as they take fewer risks in high risk environments than low risk environments. Currently the measure may lack sensitivity as drivers are only classified into one of three categories. A more sensitive measure may allow for more distinction to be made between driver hand positions although this may come at the cost of lower inter-rater reliability. This is expanded in the future research section, p 41.

Study 2: Hand Position, Speed, Headway and Gender

Zuckerman's (1979a) sensation seeking approach to risk taking suggests that individuals who take risks in one context should take risks in other contexts. Iversen (2004) finds support for this, showing volition of traffic rules and speeding is strongly related to reckless driving, drink driving, and seatbelt use. It follows that if driver hand position is in fact a risk-taking behaviour, drivers who take risks with their hand position placement should also take risks in other driving contexts.

Speeding has been identified as an important risk-taking behaviour as it affects both the severity of the crash and increases the likelihood of being involved in a crash (e.g. Elvik, Christensen & Amundsen, 2004). Palamara and Stevenson (2003) showed that a high disposition for risk taking was significantly and consistently predictive of speeding behaviour. In a meta-analysis, Elvik et al. (2004) conclude that there is a strong causal relationship between speeding and road safety. They estimate a 10 percent reduction in the mean speed of traffic will result in a 37.8 reduction in the number of fatalities. In a recent review, Aarts and Van Schagen (2006) conclude that vehicles that travel at much faster speeds than the vehicles around them have a higher crash rate. Drivers who speed also tend to engage in other forms of risk taking. Wasielewski (1984) showed that drivers with higher speeds tend to engage in a higher number of reported accidents and have more traffic violations than slower drivers. Along similar lines, Blockey and Hartley (1995) report that drivers who have previously been convicted for speeding offences tend to demonstrate a high disposition for violating formal and informal road rules.

Given that speeding behaviour is a well-established risk-taking behaviour, people who take risks by speeding should be more inclined take risks with their hand position placement. It was therefore hypothesised that drivers who place two hands on the top half of the wheel will

drive slower than drivers who place one hand and no hands on the top half of the wheel respectively.

Headway is another risk taking behaviour that has been extensively studied in the literature. It has been defined as the elapsed time between the front of the lead vehicle passing a point on the roadway and the front of the following vehicle passing the same point (Evans, 1991). Driving with short headways results in a shorter "time to collision" and increased likelihood of being involved in an accident (Van Winsum & Heino, 1996). Statistics from the MOT (2005) indicate that 10 percent of all accidents are rearend collisions. Auckland Motorway Safety (2005) reports rear end crashes make up 45 percent of all motorway accidents. Drivers who adopt short headways have also been shown to engage in other forms of risk taking. Evans, Wasielewski and Von Buseck (1982b) showed that individuals who drive with shorter headways are less likely to drive with a seatbelt.

Again, given that short headway is a well-established risk taking behaviour, drivers who drive with shorter headways should also take risks with their hand position placement. It was therefore hypothesised that drivers who place no hands on the top wheel will drive with the shortest headways followed by drivers who place drivers who place one hand and two hands on the top half of the wheel respectively.

In line with the findings that males tend to take more risk than females (e.g. Byrnes et al., 1999). It follows that, if hand position is a risk taking behaviour, sex differences should be observed in line with previous research. It is therefore hypothesised that female drivers will tend to place two hands on the wheel more frequently than male drivers.

Method

Drivers Observed

2053 (1225 male, 828 female) drivers were observed on Eastern Hutt Road, Lower Hutt, New Zealand.

Site selection

Repeated observations were made on a selected site on an 80km/h road (as opposed to a 50km/h road) in an attempt to minimise external variables which may influence perceived risk (e.g. pedestrians, cyclists, domestic pets, intersections, turning vehicles etc). Observations were made in clear weather conditions.

Procedure

An Infra-Red Traffic Logger (TIRTL) measured the speed and headway of vehicles passing through the selected site. Headway was measured following the definition of Evans (1991), the elapsed time between the front of the lead vehicle passing a point on the roadway and the following vehicle passing the same point. Hand positions were recorded following the method of Walton and Thomas (2005), where the number of hands in the target zone on the top half of the steering wheel (between 3 o'clock and 9 o'clock on an analogue clock face) was recorded as either zero, one or two. Two observers sat in a light commercial van to provide greater safety and better elevation to view hand positions. One observer called out the driver's hand position after which the second observer called out the driver's gender. Hand position and driver sex were spoken into a video camera positioned on the dashboard of the van which recorded the passing cars. The data was combined once all the observations had been made.

Results

Cars with short headways are influenced by the cars in front of them and hence their speed may not be a product of their own choice. For this reason cars with headways less than or equal to 4 seconds (approximately 89m) were excluded from the analysis when examining the relationship between speed and hand position. This criterion was adopted from Wasielewski (1979) who noted that vehicles with headways larger than four seconds are not interacting with other vehicles and hence have the same statistical properties as vehicles in very sparse traffic.

A one-way ANOVA indicated that the drivers who place zero, one and two hands on the top half of the wheel have significantly different mean speeds, $F(2,982) = 8.24$, $p < .01$. As can be seen in Figure 1, drivers who placed no hands on the top half of the wheel drove faster than driver who placed one hand and two hands on the top half of the wheel respectively. Post-hoc Bonferroni analysis indicated that all differences between the groups were significant at $p<.01$.

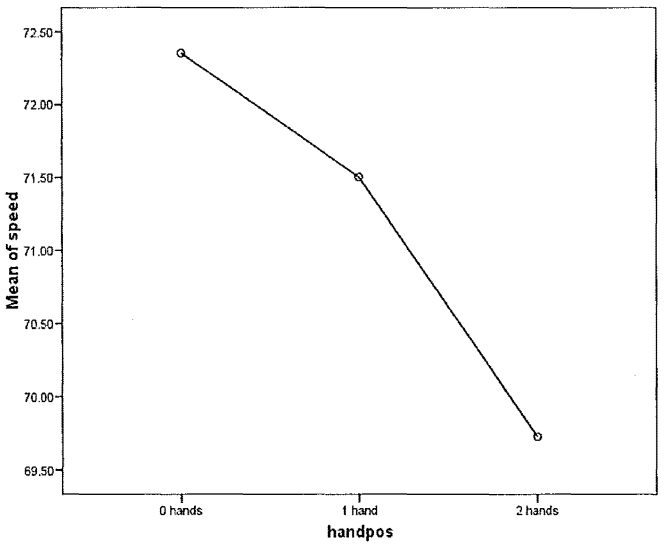

Figure 1. Mean speeds in kilometers per hour of driver with zero , one and two hands on the top half of the steering wheel.

Evans and Waielswski (1983) note that when examining headway, the most effective approach to discriminate amongst different driver groups (different hand positions), is to use the reciprocal of headway. The reciprocal refers to the multiplicative inverse i.e. 1/headway. Evans and Waielswski (1983) note the reciprocal headway is more sensitive to small headways which are most indicative of risk taking and less sensitive to larger headways which may be unrelated to risk taking. The greater the reciprocal headway, the greater the relative risk.

A one-way ANOVA indicated that drivers who place zero, one or two hands on the top half of the wheel have significantly different reciprocal headways, $F(2,2047) = 4.71, p < .01$

As can be seen in Figure 2, drivers who placed no hands on the wheel had the largest reciprocal headways (indicting greater risk taking) followed by drivers who placed one hand and two hands on the top half of the wheel respectively. Post-hoc Bonferroni analysis indicated that all differences between the groups were significant at $p<.05$.

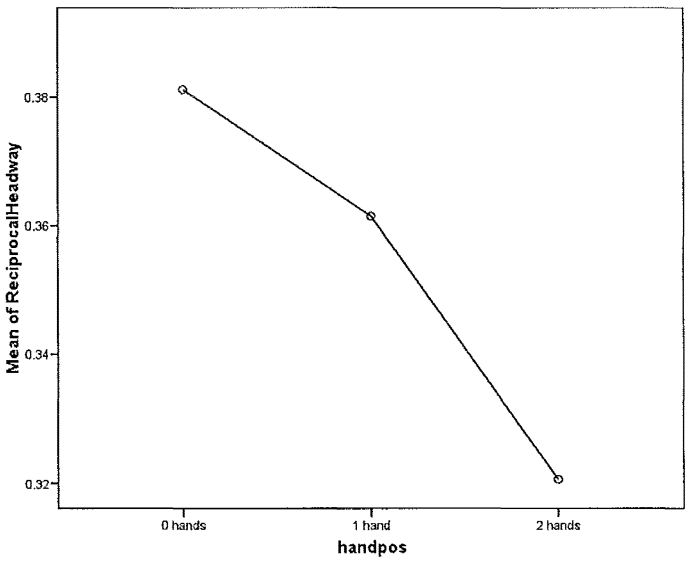

Figure 2. Mean reciprocal headway in seconds of drivers with zero, one and two hands on the top half of the steering wheel.

Table 3 outlines the hand position configurations adopted by males and females. A chi square analysis indicates that hand position was not independent of gender. Standardised adjusted residuals indicate that females are equally likely as males to drive with zero hands on the top half of the wheel. However, males compared to females tend to place one hand on the wheel significantly more frequently and two hands on the top half of the wheel significantly less frequently than would be expected. A Mantel-Haenszel common odds ratio estimate revealed that females are 2.87 times more likely than males to place two hands rather than one hand on the top half of the steering wheel $U(2) = .349$, $p<.01$.

Table 3.

Cross tabulation and chi-square analysis of the number of males and females observed placing zero, one and two hands on the top half of the wheel.

			Gender		
			Female	Male	Total
Hand Position	zero hands	Count	144	218	362
		Expected Count	146.0	216.0	362.0
		% within Gender	17.4%	17.8%	17.6%
		Adjusted Residual	-.2	.2	
	one hand	Count	373	780	1153
		Expected Count	465.0	688.0	1153.0
		% within Gender	45.0%	63.7%	56.2%
		Adjusted Residual	-8.3	8.3	
	two hands	Count	311	227	538
		Expected Count	217.0	321.0	538.0
		% within Gender	37.6%	18.5%	26.2%
		Adjusted Residual	9.6	-9.6	
Total		Count	828	1225	2053
		Expected Count	828.0	1225.0	2053.0
		% within Gender	100.0%	100.0%	100.0%

Conclusion

Support was found for hand position as a risk taking behaviour. Drivers who place zero hands on the top half of the steering wheel also tend to travel at the fastest speeds and with the shortest headways (demonstrated by larger reciprocal headways). This is followed by drivers who place one hand and two hands on the top half of the wheel respectively. One would assume that if hand position was unrelated to risk taking, drivers should place more hands on the top half of the wheel to in an attempt to gain greater control of the vehicle.

Support for hand position as a risk taking behaviour was also found in that males compared to females tend to place one hand on the wheel significantly more frequently and zero hands on the top half of the wheel significantly less frequently than would be expected. This is line with the literature on sex differences in risk taking behaviour.

Although this findings offer support for hand position as a risk taking behaviour, caution should be taken in drawing conclusions as the finding could be confounded by variables such as Anthropometrics. Women are approximately 52% and 66% as strong as men in the upper and lower body respectively (Miller, MacDougall, Tarnopolsky & Sale, 1992). Miller et al. also showed men are stronger relative to lean body mass. Females may need to place both hands on the top half of the wheel to have the same control that a male can have with one or zero hands.

Similarly, confidence could also offer an explanation into the sex differences found in driver hand position. Marottoli and Richardson (1998) have shown that driver confidence is associated with driving frequency and millage. Based on the figures given in the preliminary New Zealand House Travel Survey (2007) for data over 2003/2004, a female travels an average of 10 871 km/year compared to a male who travels an average of 18 697 km/year. In

line with Marottoli and Richardson, this suggests male drivers in New Zealand should be more confident than female drivers.

The results offer support to the argument, driver risk taking may underlie Walton and Thomas' (2005) finding that drivers alter their hand position as a function of the environment. The finding that drivers who travel at faster speeds are more likely to drive with no hands on the top half of the wheel appears to contradict Walton and Thomas's finding that drivers in high speed zones placed more hands on the top half of the wheel than low speed zones. However Walton and Thomas's finding is taken out of context when examining relationships within a speed zone. When a driver moves from a 50km/h zone to a 100km/h zone, the driver is forced to increase their speed and therefore risk as a product of the environment. Conversely, within a speed zone the environment remains relatively stable whereby variations in drivers' speeds may be more due to individual differences than changes in the environmental context. Consequently, drivers who perceive less risk in the environment may feel they can take more risks thereby increasing their speeds, driving with shorter headways and placing fewer hands on the top half of the wheel.

It is evident that although hand position relates to speed, headway and gender as hypothesised, further research is required to move from making inferences based on observed behaviour to assessing whether a direct link exists between hand position and risk taking. The third study examines the relationship between driver hand position and risk taking and identifies psychological variables that may be associated with driver hand position.

Study 3: Psychological Predictors of Hand Position

Rothengatter (2002) notes that research on accident risk was at its peak around 1972 in the US and Europe and by the time traffic psychology emerged, road accidents were already declining. He attributes this decline in a small part to legislation but mostly to engineering achievements such as divided highways, crash barriers and vehicle design (e.g. the introduction of seatbelts). Importantly, Rothengatter notes that many of these measures reduce the severity of accidents, but to actually address the way people drive we need to attempt to modify their behaviour. Therefore the when examining how one might modify a driver's behaviour to place both hands on the top half of the wheel, we need to examine the psychological variables that influence driver hand position.

The study 2 findings offer support to the overall argument that driver hand position is related to individual risk taking although they are based on observed behaviours which may have been influenced by unmeasured driver characteristics. A direct measure of individual risk taking is needed to conclude it is related to driver hand position. It is hypothesised that drivers who place no hands on the wheel will be higher risk takers than drivers who place one hand and two hands on the wheel respectively.

The Theory of Reasoned Action/Planned Behaviour (Ajzen & Fishbein, 1980; Ajezn 1988) takes a social cognitive approach to risk taking. The model views attitudes, perceived behavioural norms and perceived behavioural control as key determinants in an individual's intention to engage in a risky behaviour. Brown and Cotton (2003) identified that most models of volitional behaviour change suggest people become motivated to change behaviours when they realise their behaviours place them at risk of personal harm. On these lines, they note the importance of erroneous beliefs with regard to risky behaviours and risk taking. They found that erroneous beliefs surrounding the risk of speeding positively

correlated with self reported speeding. Following this, beliefs around hand position and control of the vehicle should relate to hand position placement. Drivers who do not believe placing more hands on the top half of the wheel will give them greater control of the vehicle should place fewer hands on the top half of the wheel. It is hypothesised that the stronger a drivers belief that hand position gives more control of the vehicle, the more likely they will be to place both hands on the top half of the wheel.

Another variable which has been extensively studied in risk taking literature is optimism bias. Moen & Rundmo (2005) define optimism bias as a tendency to report being less likely than others to experience negative events, and more likely than others to experience positive events. Dejoy (1992) notes that although drivers have accurate perceptions of societal traffic risks (Lichtenstein, Slovic, Fischhoff, Layman, and Combs, 1978), they believe that aggregate risk estimates do not apply to them personally. Drivers tend to think that they are safer, more skilful and less likely to be involved in an accident than the average driver (DeJoy 1989; Goszczynska & Roslan 1989; McCormick, Walkey & Green 1986; Svenson 1981; Svenson, Fischhoff & MacGregor 1985).

Hatfield & Job (2000) argue that optimism bias is related to risk taking in road users. Weinstein (1989) notes a clear potential consequence of an optimism bias is that if people underestimate their personal risk, they will have less incentive to protect themselves. A number of researchers have shown that males tend to be more optimistic in judging their driving skill and judging their safety relative to the average driver than females (DeJoy, 1992; Finn & Bragg, 1986; Matthews & Moran, 1986). If optimism bias is related to risk taking, it may offer an insight in to sex differences in driver hand position found in study 2.

Methodological issues have been raised about asking participants to compare their driving ability to other drivers when measuring optimism bias. Researchers such as McKenna, Stanier and Lewis (1991) and Walton and Bathurst (1998) have pointed out that the problem

with a relative difference is that it can always be interpreted in two ways. It is impossible to tell whether a 'difference rating' is due to a driver being overly optimistic about their driving ability or due to the driver having an accurate perception of their ability but thinking the average driver is unskilful with unsafe driving practices. This alternative has been termed 'negative other' (Walton & Bathurst, 1998). Regardless of the direction of the self enhancement bias, it is hypothesised that those drivers who view themselves as safer, more skilful and less likely to have an accident than the average driver, will be less likely to place two hands on the top half of the wheel.

Whilst optimism relates to drivers perception of their safety, skill and accident likelihood relative to others, driver confidence relates purely to the individual. Parker, McDonald, Sutcliffe and Rabbitt (2001) view driver confidence as the extent to which drivers remain calm whist engaging in various driving manoeuvres. This served as the definition of driver confidence for the current study. Parker et al. (2001) showed that higher levels of driver confidence were associated with fewer lapses and errors and higher levels of self reported violations. As discussed earlier, drivers with more exposure tend to be more confident and males in New Zealand tend to drive further per year on average than females. As such, if confidence is related to driver hand position, it may offer an insight into the sex differences found in study 2. It is hypothesised that drivers with no hands on the top half of the wheel will have more confidence than drivers who place one hand and two hands on the top half of the wheel respectively.

West et al. (1992) have argued that self reported driving behaviour can serve as a surrogate for observed driver behaviour. West et al found statistically significant correlations between a number of observed and self report driver behaviours including speeding and calmness while driving. Hence self reports of driver behaviour can offer an insight into the habits and styles of drivers.

Method

Drivers Observed

630 drivers were observed on Eastern Hutt Road, Lower Hutt, New Zealand. Drivers of heavy vehicles, motorbikes and easily identifiable commercial vehicles, such as taxis will be excluded from the study. Of the 630 drivers, surveys were sent to 500 (250 males and 250 females). 233 were returned (46.6 percent response rate), 116 males, 116 females, 1 unknown, with a mean age of 49.83 years (SD = 15.13).

Site selection

Repeated observations were made on an 80km/h road in an attempt to minimise external variables which may influence perceived risk (e.g. pedestrians, cyclists, domestic pets, intersections, turning vehicles etc). Specifically, drivers were observed on Eastern Hutt road, Lower Hutt. Observations were made in clear weather conditions.

Procedure

An Infra-Red Traffic Logger (TIRTL) measured the speed and headway of vehicles passing through the selected site. Hand positions were recorded following the method of Walton and Thomas (2005), where the number of hands in the target zone on the top half of the steering wheel (between 3 o'clock and 9 o'clock on an analogue clock face) was be recorded as either zero, one or two. A video camera was synchronized with the TIRTL. Observers sat in a light commercial van to provide greater safety and better elevation to view hand positions. Hand positions, sex and vehicle number plate were spoken into the video camera as the cars passed the vehicle. The first observer called out driver sex and driver hand position after which observer two called out the associated vehicle number plate.

Licence plate details were obtained from the Motor Vehicle Registry in Palmerston North, New Zealand. A questionnaire was constructed to measure a number of driver characteristics, attitudes and behaviours. These included driver age, sex, exposure, vehicle transmission, optimism bias, risk taking, confidence, hand position beliefs and self reported hand position. For the purposes of this study only the variables optimism bias, risk taking, confidence, hand position beliefs and self report hand position were considered. To ensure anonymity, no personal information was requested in the questionnaire. Questionnaires were sent to 500 drivers whose actual behaviour had been observed. Data was stratified based on sex and hand position whereby questionnaires were sent to 250 females (90 who were observed with two hands on the top half of the wheel, 111 with one hand on the top half of the wheel and 49 with zero hands on the top half of the wheel) and 250 males (48 who were observed with two hands on the top half of the wheel, 134 with one hand on the top half of the wheel and 68 with zero hands on the top half of the wheel). This was done to mitigate any sex biases and achieve a good distribution of self report hand positions.

Participants' privacy was managed by informing them exactly what the study involved. They were further informed that they might decide whether or not they wished to participate in the questionnaire. Participants were informed of their usual rights (withdraw at any point, able to request information about the study). They were given a full disclosure on how their details were obtained and they were inform them that their details obtained from the Motor Vehicle Registry were destroyed at the time of delivery, so their name and address details were not kept on any record.

Questionnaire

The questionnaire measured four variables that were hypothesised to influence driver hand position, namely, optimism bias, risk taking behaviour, driver confidence, and driver belief around hand position and control of the vehicle. A copy of the Questionnaire can be found in Appendix A.

Optimism bias was measured using nine items. Items used reflected the optimism measures used by Dejoy (1992) when measuring sex differences in optimism bias., Dejoy (1992) asked drivers to judge their overall driving safety, skill, and accident likelihood relative to two referent groups, namely, other drivers of their age and sex, and the average motorist. Taking into consideration the criticisms of McKenna, Stanier and Lewis (1991) and, Walton and Bathurst (1998), instead of adopting the exact methodology of Dejoy (1992), drivers were asked to rate overall safety, skill and accident likelihood of themselves and the two referent groups on separate scales. A five point Likert scale was used ranging from one being very unsafe (safety), unskilful (skill) and unlikely (accident likelihood) to five, being very safe, skilful and likely.

Risk taking behaviour was measured using three scales (15 items) designed by Ulleberg & Rundmo (2003), to measure self reported acts of risk taking in traffic, namely; speeding, rule violations and self-assertiveness. Ulleberg & Rundmo (2003) found the Cronbach alphas associated with the scales to be .91, .86 and .73 respectively). Items required drivers to rate the frequency with which they engaged in 15 risk taking behaviours such as breaking traffic rules due to peer pressure and disregarding a red light on an empty road. Items were measured using a five point Likert scale ranging from one being never to five being always.

Driver confidence was measured using a driver confidence scale created by Parker, MacDonald, Sutcliffe and Rabbitt (2001). Seven items measured on a five point Likert scale

required respondents to rate how nervous a range of driving situations usually makes them feel. A further three items asked how relaxed, stressed and confident respondents usually feel while driving. The remaining two items asked how calm and how flustered respondents are in situations likely to provoke anxiety while driving. Items were measured on a five point Likert scale ranging from one being not at all to five being extremely.

Drivers' belief that placing two hands on the top half of the steering wheel will give increased control was measured using a six item scale. Items asked respondents to what extent they agreed/disagreed with statements regarding hand placement and control of the vehicle. Items included, "Placing two hands on the top half of the wheel would give me greatest control of the vehicle" and, "It doesn't matter where you place your hands on the steering wheel, you will always have the same control level (reversed scored)". Items were measured on a five point Likert scale ranging from one being strongly disagree to five being strongly agree.

Respondents were shown a figure of a picture depicting three potential hand position placements, two hands on the top half of the wheel, one hand on the top half of the wheel and zero hands on the top half of the wheel. Self reported driver hand position was measured using five items asking individuals what hand position they would adopt under different circumstances. Items included "your typical hand position when driving" and "your hand position when tense". Respondents were required to tick the hand position that best described the hand position they tended to adopt. Jonah (1990) notes that direct observations of driver behaviour are needed to validate self reports. To establish the convergent validity of the scale, driver self report position should correlate with the single observation of driver hand position.

Results

An exploratory factor analysis was run on each scale extracting one factor to ensure the items were adequately loading on the scale factor. A number of issues were taken into consideration when selecting the factor loading cut-off. It has been well established in the literature that drivers tend to think themselves better than the average driver (e.g. Svenson, 1981), hence there is expected to be range restriction with regard to the attitudes and behaviours measured. In addition, the constructs measured are likely to be multidimensional e.g. risk taking which may be composed of speeding, rule violations and self assertiveness, and hence only a weak general factor was expected. As a result the factor loading cut-off was set at 0.2. All items had factor loadings above the set cut-off of 0.2 and therefore no items were removed from the scales.

All items were summed to form a composite score for each scale. Missing data was addressed using the method outlined by Bryman and Cramer (2001) where the mean score of the non missing items was multiplied by the total number of items. This was done on all scales.

Sex differences were examined to ensure that the sex bias in driver hand position had been adequately controlled for in the stratification process. Of the surveys returned, a t-test revealed no significant sex differences in observed driver hand position $t(230) = -.183$, $p =$ n.s or self report driver hand position, $t(229) = -1.223$, $p =$ n.s.

All scales were correlated to ensure they were all functioning as expected. Of the 233 surveys returned, there were 183 sex matches whereby the sex of the individual observed driving on Eastern Hutt road matched the sex of the individual filling out the questionnaire. This suggests that the 50 questionnaires that did not match were filled out by a different individual to the driver observed. To refrain from losing data, two correlation tables are presented. Table 4 included only questionnaires where the observed gender matched the questionnaire

although included observed hand position. Table 5 included the full data set and only variables included in the questionnaire.

Cronbach's alpha was used to assess the internal reliability of the scales. Tables 4 and 5 indicate the reliabilities and correlations of the scales. All items had a reliability coefficient of above 0.7 which Nunnaly (1978) indicates to be an acceptable reliability coefficient.

Table 4.

Correlations of psychological variables, self reported hand position and observed hand position where observed gender matched the survey gender

	Items	M	SD	1	2	3	4	5	6
1.Optimism Bias	6	4.06	3.18	(.70)					
2.Risk Taking	14	20.11	4.57	-.12	(.83)				
3.Driver Confidence	12	50.41	5.59	.21**	-.10	(.86)			
4.Hand Position Beliefs	6	24.04	3.64	.03	-.11	-.04	(.70)		
5.Hand Position Self Report	5	8.53	1.84	-.16*	-.25**	-.03	.26**	(.80)	
6.Hand Position Observed	1	1.07	0.71	-.08	-.05	-.11	.02	.22**	(n/a)

Note: N = 183

* significant at p<.05

** significant at p<.01

Observed driver hand position correlated significantly with self reported hand position r = .219, p<.01. This finding demonstrates that self reported hand position has convergent validity. Hand position observed did not correlate significantly with other variables measured. A limitation may lie in that even though data was excluded if the observed gender did not match the survey gender, it would be presumptuous to assume all the surveys were completed by the driver who was observed. In addition, single observations suffer from large amounts of measurement error and have been criticised as not being useful in testing hypotheses unless they can be compared to observations made by other researchers (King,

Keohane & Verba, 1994). The psychological variables measured examined general driver behaviour, whereas observed hand position was context specific. Hence, self reported hand position was used to further examine the relationships between hand position and the psychological variables measured.

Table 5.

Correlations of psychological variables and self reported hand position with all survey data included.

Scale	Items	M	SD	1	2	3	4	5
1.Optimism Bias	6	4.05	3.26	(.72)				
2.Risk Taking	14	20.11	4.51	.08	(.83)			
3.Driver Confidence	12	50.54	5.63	.26**	-.07	(.85)		
4.Hand Position Beliefs	6	24.00	3.74	.08	-.09	-.06	(.70)	
5.Hand Position Self Report	5	8.57	1.84	-.17*	-.27**	-.05	.33**	(.73)

Note: N = 233

* significant at p<.05

** significant at p<.01

Individuals who reported higher risk taking behaviour tended to report placing fewer hands on the top half of the wheel. Optimism bias was positively related to confidence whereby individuals who report being highly optimistic with regard to their safety, skill and accident likelihood also tend to be report being more confident drivers. Optimism bias was also found to be negatively related to hand position self report whereby highly optimistic drivers report placing fewer hands on the top half of the steering wheel. Optimism bias did not significantly relate to risk taking. Individuals with stronger hand position beliefs reported placing more hands on the top half of the wheel.

Table 6 shows the results of a multiple regression of the psychological variables optimism bias, risk taking and hand position beliefs on self reported hand position. Optimism bias, risk taking and hand position beliefs significantly predicted self reported hand position.

Table 6.

Regression of psychological variables on self report hand position

Predictor	B	Standard Error	β	*t*	*p*
(Constant)	7.40	.89		8.27	.00
Risk Taking	-011	.02	-.26	-4.42	.00
Optimism Bias	-.12	.03	-.21	-3.61	.00
Hand Position Beliefs	.16	.03	.32	5.44	.00

Note: Dependent variable is self report hand position, $R^2 = .213$

Drivers who tend to place more hand on the top half of the wheel report being less risk taking, less optimism biased and have stronger beliefs that hand position is related to control of the vehicle.

Conclusion

Observed hand position was not related to any of the psychological variables measured apart from hand position self report. Self report hand position however was related to and could be predicted by a drivers reported level of risk taking. This finding offers tentative support to the hypothesis that driver hand position is related to risk taking. Ideally risk taking would have predicted observed hand position. Observed hand position was however only based on a single observation in a single driving context. Self report hand position took into consideration the hand position a driver would adopt across a number of driving contexts.

Self report hand position can also be predicted by hand position beliefs, where the stronger a drivers' beliefs are that placing both hands on the top half of the wheel gives them more control, the more likely they are to report placing both hands on the top half of the steering wheel. Similarly self report hand position can be predicted by the level of optimism bias of the driver. The greater the extent to which drivers believe themselves to be safer, more skilful, and less likely to have an accident than the average driver, the more hands they tend to report placing on the top half of the wheel.

The hypothesis that driver confidence would relate to driver hand position was not supported either for observed driver hand position or self report hand position.

Discussion

Three studies were conducted to assess the overall research question; does driver hand position relate to individual risk taking. The first study found that driver hand position could be reliably measured and that average hand position remained constant under similar conditions and across time. The second study showed that females drive with two hands on the wheel more frequently than males. It further showed drivers who place fewer hands on the top half of the wheel also drive with shorter headways and at faster speeds. The third study showed that self reported hand position was significantly related to driver risk taking, optimism bias and hand position beliefs about control of the vehicle. Overall it is argued the findings from the studies support the argument that hand position is related to individual risk taking and the implications of the findings are discussed.

Walton and Thomas (2005) found that only 25 percent of drivers place two hands on the top half of the wheel. The question arises as to who the drivers are who are placing themselves at risk by driving with minimal control of the vehicle. Three studies were conducted to specifically address whether the drivers who are placing themselves at risk with their hand position placement are also the drivers who are placing themselves at risk in other driving scenarios. A major implications being that if hand position is related to risk taking, then it can be targeted. Part of the "Road safety to 2010" strategy involves reducing a number of risk taking behaviours such as reducing speed, combating drink-driving and encouraging the use of seatbelts. As noted, little or no interest has been taken in the one behaviour that gives drivers control of the vehicle, driver hand position.

Walton and Thomas (2005) suggest that average driver hand position varies as a function of the complexity of the environment although no studies to date have demonstrated that

average hand position remains constant under similar conditions and across time in the same conditions. The first study aimed to assess whether hand position can be reliably measured. ,

Results indicate that the method of measuring driver hand position adopted by Walton and Thomas (2005) and Thomas and Walton (2007), has good inter-rater reliability and therefore even though observer judgement is required, hand position can be accurately observed. In line with the behavioural compensation framework, drivers should take similar risks under similar conditions. This found to be the case for driver hand position. The results showed that average hand position remained constant under similar conditions and across time under the same condition thereby demonstrating the contextual and temporal reliability of the measure. This adds validity to the findings of Walton and Thomas (2005) suggesting that variations in hand position across contexts does not occur randomly. The findings support the argument that driver hand position as a risk taking behaviour could offer an explanation, at an individual level, to the finding of Walton and Thomas (2005).

Once it was established that hand position could be reliably measured, the overall research question as to whether driver hand position related to individual risk taking was then further investigated. Based on the findings of researchers such as Evans et al. (1982b) and Iverson (2004) who showed that drivers who take risks in one context tend to take risks in other contexts, it was hypothesised that if driver hand position was related to risk taking, then drivers who take risks in one driving context (speeding or driving with a short headway) should also take risks with their hand position. This was found to be the case. The hypothesis that that drivers who place two hands on the wheel will drive slower than drivers who place one hand and no hands on the top half of the wheel respectively was supported. This shows that drivers who place no hands on the top half of the wheel tend to travel at the fastest speeds.

A similar finding was found for headway. Drivers who placed two hands on the wheel drove with larger headways (as demonstrated by smaller reciprocal headways) than drivers who placed one hand and zero hands on the top half of the wheel respectively. Again, this demonstrates that drivers who are placing no hands on the top half of the wheel are driving with the shortest headways. These findings are consistent with Zuckerman's sensation seeking theory of risk taking, which views risk taking as an underlying construct, and offer support to the overall argument that the hand position drivers adopt is related to their level of risk taking.

In itself, this finding shows that those drivers who arguably need the greatest control of the vehicle, the drivers who are travelling at higher speeds and with shorter headways are driving with no hands on the top half of the wheel. If hand position relates to control of the vehicle, it may be confounding the relationship between accident risk and the current risk taking behaviours measured, namely, speeding and short headway. Hand position (control of the vehicle) could be taken into consideration in future studies examining the relationship between speeding (as well as short headway) and accident likelihood.

Gender differences in driver hand position were also examined to assess whether driver hand position is related to individual risk taking. A number of researchers (e.g. Byrnes et al., 1999) have shown that males tend to take more risks than females. It followed that if hand position relates to individual risk taking, males should take more risks with their hand position placement than females. The findings showed males compared to females tend to place one hand on the wheel significantly more frequently and two hands on the top half of the wheel significantly less frequently than would be expected. This finding offers further support that hand position is related to driver risk taking.

Importantly, these associations are based on observations of driver behaviour and as such may be affected by driver characteristics that were not measured in the study. Following this,

although the findings offer strong support that a relationship exists between risk taking and hand position, the third study attempted to move from making inferences based on observed behaviours to directly examining the relationship between an individual's level of risk taking and their hand position they adopt.

The study examined the relationship between hand position and other psychological variables that have been shown to be related to risk taking. Drivers hand positions were observed after which they were sent a questionnaire measuring driver risk taking, confidence, hand position beliefs and self reported hand position. No relationship was found between observed hand position and any of the psychological variables measured. Hand position self report, did however positively and significantly correlate with observed hand position. This indicated that drivers are to some extent aware of the hand position they adopt. Given that observed driver hand position was based on a single observation in a single driving context, the variables relationship to self report hand position was further examined.

Self reported driver hand position was found to be significantly related to, and can be predicted by, a driver's level of risk taking. Individual's who report taking risks whilst driving, also report placing fewer hands on the top half of the wheel. This finding is in line with the findings of study two whereby drivers who placed no hands on the top half of the wheel drive drove at faster speeds and with shorter headways than driver who placed one hand and two hands on the wheel respectively. The finding offers strong support to the argument that driver hand position is related to individual risk taking.

The finding that hand position is related to risk taking at an individual level offers an explanation to the findings of Walton and Thomas (2005) that driver hand position varies as a function of the environment. In line with the behavioural compensation framework, drivers may take fewer risks (with their hand position) in high risk situations than low risk situations.

The finding offers further insight into the findings of Thomas and Walton (2007) who found at an aggregate level SUV drivers (who engage in higher levels of risk taking than car drivers (Wasielewski & Evans, 1985)) placed significantly fewer hands on the top half of the steering wheel. SUV drivers may perceive less risk whist travelling in their vehicle and as such take more risks with their hand position than car drivers although the findings suggest further research is required to ensure that individuals who are naturally more risk taking aren't overrepresented in SUV drivers.

Self reported driver hand position was significantly related to optimism bias. Drivers who consider themselves safer, more skilful and less likely to be involved in an accident than other drivers are more likely to report placing fewer hands on the top half of the wheel. Weinstein (1989) suggests that an optimism bias may lead people to underestimate their personal risk. Drivers who believe themselves' to be safer, more skilful and less likely to involved in an accident than average may perceive less risk in the environment and as such take more risks with their hand position. As such the drivers who believe they are safer and least likely to be involved in an accident, may be at a higher risk of being involved in an accident. Alternatively, highly optimistic drivers may have accurate perceptions of their driving skill, safety and accident likelihood and as such not need to place two hands on the top half of the wheel to achieve the same level of control as other drive. Given that males have shown to be more optimistic than females (DeJoy, 1992; Finn & Bragg, 1986; Matthews & Moran, 1986), this finding may offer an insight into the driver hand position sex difference found in study 2.

No relationship was found between driver confidence and self reported driver hand position. This suggests that the extent to which drivers remain calm whilst driving is unrelated to the hand position a driver reports adopting.

A potential explanation for the absence of a relationship between hand position and driver confidence may be that driver hand position could be seen as a behavioural response to driver confidence. For example, confident drivers may place fewer hands on the wheel because they are confident or, alternatively, confident drivers may be confident because they place two hands on the wheel. The issue arises that at an individual level, it may be impossible to tell whether a driver with two hands on the top of the wheel is a confident driver because he places two hands on the wheel, or is less confident therefore feels the need to place two hands on the wheel.

Driver hand position was shown to be related to the extent to which drivers believe placing two hands on the wheel gives them greater control of the vehicle. The weaker driver belief that hand position relates to control of the vehicle, the fewer hands they reported placing on the top half of the wheel. This suggests that hand position behaviours could be modified by making drivers aware that hand position relates to increased control of the vehicle and is linked to crash involvement. It provides a solid basis for the construction of a safety campaign. However, the finding that hand position also relates to optimism bias means the safety campaign would need to be constructed carefully. Walton and Mckeown (2001) showed that drivers who believe they drive faster than the average driver will accept advertising messages as aimed at themselves. However those who believe they drive slower than average will view the campaign as aimed at others.

This may have important implications for hand position as drivers who do not believe they drive with fewer than two hands on the top half of the wheel will not perceive an advertising campaign as being directed at themselves. To combat this, an advertising campaign may consider billboards questioning drivers about their current hand position to make drivers aware they are not driving with two hands on the top half of the wheel.

Limitations

Although the current measure of driver hand position adopted from Walton and Thomas (2005) has good inter-rater reliability, it only classifies driver hand position into one of three categories and therefore may lack sensitivity in that relationships examined may be underestimates of the "true" relationship between hand position and the identified variables. A more sensitive measure may afford the opportunity to gain a better understanding of driver hand position and its relation to other variables.

Study 2 relied on a single observation of driver hand position, headway and speed. Multiple observations of driver hand position, gender, speed and headway would allow for more accurate estimations of the relationships between these variables. Similarly, in Study 3 although self reported hand position and observed hand position correlated, more accurate estimations of actual driver hand position could have been gained by making multiple observations of driver hand position across varying driving contexts i.e. using an aggregate observed hand position score instead of relying on self reported hand position.

The mean age of Study 3 was relatively high (M=49.83). This combined with a relatively small sample size of 233 suggests that caution should be taken in generalising the results to a younger population.

Future Research

Now that support has been found to suggest hand position is related to risk taking, further research is needed to quantify the relationship between hand position and control of the vehicle. This could be done with the use of a driving simulator, requiring drivers to adopt various hand positions and react to changes in the environment such as a swerving car or a wayward pedestrian. Although unlikely, if hand position is completely unrelated to control of the vehicle and accordingly driver objective risk, then hand position would only be useful as a measure of driver risk taking and as such interventions to increase the number of hands drivers should place on the wheel would not be necessary. Alternatively if hand position did relate to control of the vehicle, quantifying the relationship between hand position and objective risk will offer an insight into exactly how much more danger a driver is placing themselves in when placing fewer hands on the top half of the wheel. Quantifying the relationship would also help to address a limitation of the study, only having three possible categories of driver hand position. A more intricate understanding of hand position and control of the vehicle would afford the development of a more sensitive measure of driver hand position.

To add greater understanding as to why drivers change their hand position as a function of the environment, it would be beneficial to examine how drivers change their behaviour across driving contexts and environments at individual levels. For example, at road work sites drivers are forced to change their speeding behaviour due to speed signs, although their hand position is still subject to their own judgement. An interesting insight could be gained into risk taking at road work sights by examining driver hand position.

Currently there has been a large movement into improving delineation (signs and markings) on New Zealand roads. Driver hand position at the individual level could offer an insight into

the effectiveness of these interventions by examining how drivers' levels of risk taking (hand position) changes once the intervention is put in place. In line with the view of Walton and Thomas (2005) and Thomas and Walton (2007) changes in hand position could be examined pre and post intervention to examine the change in the level of risk taking drivers are willing to engage in.

Finally, now that optimism bias, risk taking and hand position beliefs have been shown to be related to, and predictive of, driver hand position, it would be beneficial to continue to identify further psychological variables that are related to hand position. This would provide greater insight into the mechanisms behind hand position, and show how we can alter drivers' behaviour in such a way to increase the number of hands drivers place on the wheel therefore increasing driver safety.

Conclusion

The measure of driver hand position adopted by Walton and Thomas (2005) is reliable across observers and time and as such we can accurately observe individuals hand positions to gain a new perspective on driver behaviour. Overall the results suggest that driver hand position is related to individual risk taking. In support of this, drivers who are driving with no hands on the top half of the wheel, drive at the highest speeds and with the shortest headways. The finding that self reported hand position relates to belief about hand position and control of the vehicle further suggests that drivers may actually be unaware they are taking risks. Hand position may offer a valuable insight into the contribution of loss of control to accident involvement identified by the MOT (2005) and as such it could be investigated further. Hand position could be targeted in the same way as other risk taking behaviours are targeted although due to its relation to optimism bias, caution should be taken in doing so. If correctly addressed, targeting driver hand position may help draw further awareness to the risks drivers are taking and reduce injury and fatalities on New Zealand roads.

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Appendices

Appendix A: Driver Behaviour Questionnaire

Driver Behaviour Survey

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What this survey is about

The purpose of this survey is to gain a better understanding of driver behaviour and the extent to which driver behaviour can signal drivers' risk perception. The study is being conducted as part of a University of Canterbury Masters Degree.

IMPORTANT POINTS

1. ***We value your opinion***
2. ***If a question doesn't make sense then let us know, but try to answer by choosing the most appropriate response***
3. ***We will not ask you to identify yourself for the survey, so your answers are entirely confidential***
4. ***You may withdraw your participation at any point***

This survey should take about *[Needs to be piloted]* ***minutes***

Driver Gender *[please indicate you gender by ticking the appropriate box]*	**Male**	**Female**
1. Gender	☐	☐

Driver Exposure

[please answer the following questions to the best of your ability]

1. **How many years have you been driving motor vehicles?**

☐ 0-3 years ☐ 4-7 years ☐ 8-11 years ☐ 12-15 years ☐ 16-19 years ☐ 20-23 years ☐ 24-27 years ☐ 28-31 years ☐ 32-35 years ☐ More than 35 years

2. **How many years have you had your full drivers licence for?**

☐ 0-3 years ☐ 4-7 years ☐ 8-11 years ☐ 12-15 years ☐ 16-19 years ☐ 20-23 years ☐ 24-27 years ☐ 28-31 years ☐ 32-35 years ☐ More than 35 years

3. **A typical privately owned motor vehicle would travel about 14,000 kilometres each year. Please estimate how far <u>you</u> travel in your private motor vehicle each year**

Travel distance per year ☐ Much Less ☐ Slightly Less ☐ About the same ☐ Slightly More ☐ Much More

The following section relates to your attitudes to driving and other drivers. This section is important as it lets us understand the motivations and desires that influence your driving behaviour. Some of the statements may relate to other areas of your life, these statements are relevant as they give us better insight when trying to understand your general perspective on life. If you feel that any of the statements are overly personal just skip them and move on to the next statement.

Driver Safety *[please complete the sentences by ticking the most appropriate box]*	Much Less Safe	Somewhat Less Safe	Equally Safe	Somewhat Safer	Much Safer
4. My driver safety relative to other drivers my age and sex is	☐	☐	☐	☐	☐
5. My driver safety relative to the average motorist is	☐	☐	☐	☐	☐
Driver Skill *[please complete the sentences by ticking the most appropriate box]*	Much Less Skilful	Somewhat Less Skilful	Equally Skilful	Somewhat more Skilful	Much more Skilful
6. My driver skill relative to other drivers my age and sex is	☐	☐	☐	☐	☐
7. My driver safety relative to the average motorist is	☐	☐	☐	☐	☐
Accident Likelihood *[please complete the sentences by ticking the most appropriate box]*	Much Less Likely	Somewhat Less Likely	Equally Likely	Somewhat more Likely	Much more Likely
8. My likelihood of being in a motorcar accident relative to drivers my age and sex is	☐	☐	☐	☐	☐
9. My likelihood of being in a motorcar accident relative to the average motorist is	☐	☐	☐	☐	☐

Accident Potential *[please tick the box you feel best describes the likelihood the behaviour may result in an accident]*	Highly Unlikely	Fairly Unlikely	Neutral	Fairly Likely	Highly Likely
10. Exceeding the posted speed by between 20 - 30 km/h	☐	☐	☐	☐	☐
11. Failing to give way to pedestrians at a zebra crossing	☐	☐	☐	☐	☐
12. Driving excessively fast in conditions of limited visibility	☐	☐	☐	☐	☐
13. Driving without fastening one's seat belt	☐	☐	☐	☐	☐
14. Driving with a blood alcohol level slightly above the legal limit	☐	☐	☐	☐	☐
15. Failing to give way to another vehicle	☐	☐	☐	☐	☐
16. Exceeding the displayed speed limit by more than 30km/h	☐	☐	☐	☐	☐
17. Tailgating or following the vehicle in front too closely	☐	☐	☐	☐	☐
18. Failing to stop at a red light	☐	☐	☐	☐	☐
19. Turning where U-turns are prohibited	☐	☐	☐	☐	☐
20. Making a turn without indicating	☐	☐	☐	☐	☐

Accident Potential *[please tick the box you feel best describes the likelihood the behaviour may result in an accident]*	Highly Unlikely	Fairly Unlikely	Neutral	Fairly Likely	Highly Likely
21. Driving with a blood alcohol level 50% over the legal limit	☐	☐	☐	☐	☐
22. Driving with one or more badly worn tyres	☐	☐	☐	☐	☐
23. Passing another vehicle where visibility is obscured	☐	☐	☐	☐	☐
24. Failing to make a full stop at a stop sign	☐	☐	☐	☐	☐

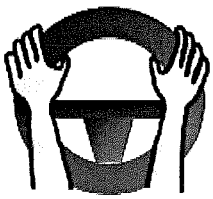
Risk Taking Behaviours *[please tick the box that best describes the frequency with which you engage in the following behaviours]*	Never	Rarely	Sometimes	Often	Always
25. Drive recklessly because others expect me to do it	☐	☐	☐	☐	☐
26. Drive fast to show others I am tough enough	☐	☐	☐	☐	☐
27. Drive fast to show others I can handle the car	☐	☐	☐	☐	☐
28. Break traffic rules due to peer pressure	☐	☐	☐	☐	☐
29. Drive fast because the opposite sex enjoys it	☐	☐	☐	☐	☐
30. Exceed the speed limit in built up areas (more than 10km/h)	☐	☐	☐	☐	☐
31. Exceed the speed limit on country roads (more than 10km/h)	☐	☐	☐	☐	☐
32. Overtake the car in front of me when it is driving at the speed limit	☐	☐	☐	☐	☐
33. Drive too close to the car in front	☐	☐	☐	☐	☐
34. Bend the traffic rules in order to get ahead in traffic	☐	☐	☐	☐	☐
35. Ignore traffic rules in order to get ahead in traffic	☐	☐	☐	☐	☐
36. Drive on a yellow light when it is about to turn red	☐	☐	☐	☐	☐
37. Disregard red light on an empty road	☐	☐	☐	☐	☐
38. Drive the wrong way down a one-way street	☐	☐	☐	☐	☐

Driver Confidence *[How nervous do you usually feel?]*	Never	Rarely	Sometimes	Often	Always
39. When overtaking	☐	☐	☐	☐	☐
40. When turning right	☐	☐	☐	☐	☐
41. When negotiating a mini roundabout	☐	☐	☐	☐	☐
42. When negotiating a large roundabout	☐	☐	☐	☐	☐
43. When joining a motorway	☐	☐	☐	☐	☐
44. When changing lines on a motorway	☐	☐	☐	☐	☐
45. When driving in heavy traffic	☐	☐	☐	☐	☐

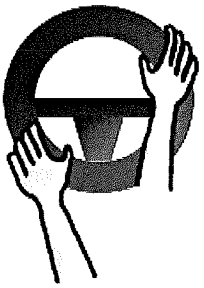
Driver Confidence *[When driving:...*	Not at all	A little	Somewhat	Very	Extremely
46. How relaxed do you usually feel?	☐	☐	☐	☐	☐
47. How stressed do you usually feel?	☐	☐	☐	☐	☐
48. How confident do you usually feel?	☐	☐	☐	☐	☐
49. When you are driving and you are suddenly faced with a potentially dangerous situation, how flustered do you become?	☐	☐	☐	☐	☐
50. When you are driving and things happen quickly giving you little time to think, how calm do you remain?	☐	☐	☐	☐	☐

Driver Strength *[how **difficult** would you find the following activities]*	Not at all	A little	somewhat	Very	Extremely
51. Opening a jar	☐	☐	☐	☐	☐
52. Lifting a 10kg bag of potatoes into a shopping trolley	☐	☐	☐	☐	☐
53. Lifting a couch up to vacuum underneath it	☐	☐	☐	☐	☐
54. Bringing a wheelbarrow of wood in for the fire	☐	☐	☐	☐	☐
55. Cutting a pumpkin in half	☐	☐	☐	☐	☐

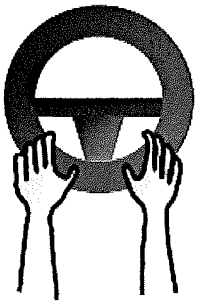
Figure 5. Examples of three common steering wheel hand positions when driving.



Two Hands
•Two hands on the top half of the steering wheel



One hand
•One hand on the top half of the steering wheel



Zero hands
•Zero hands on the top half of the steering wheel

Hand Position Beliefs *[Please indicate to what extent you agree or disagree with the following statements]*	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
56. Placing two hands on the top half of the steering wheel would give me greatest control of the vehicle	☐	☐	☐	☐	☐
57. I would be putting myself at risk driving with zero hands on the top half of the steering wheel	☐	☐	☐	☐	☐
58. You need two hands on the wheel when slowing down in a hurry	☐	☐	☐	☐	☐
59. Driving with zero hands on the top half of the steering wheel would give me enough control of the vehicle to get out of any dangerous situation	☐	☐	☐	☐	☐
60. It does not matter where you place your hands on the steering wheel, you will always have the same level of control	☐	☐	☐	☐	☐

Figure 5 above shows examples of three common steering wheel hand positions. In your opinion, which of the three hand positions best shows:	Two Hands	One Hand	Zero Hands
61. Your typical hand positions when driving	☐	☐	☐
62. Your hand position on an 80km/h road	☐	☐	☐
63. The most natural hand positions when driving	☐	☐	☐
64. Your hand positions when relaxed	☐	☐	☐
65. Your hand positions when tense	☐	☐	☐

66. **How long did this survey take you to fill out?**	..... **mins**		
67. **How difficult was this survey?**	☐ Very easy	☐ About right	☐ Very hard

Comments (we welcome your comments regarding any aspect of this survey)

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WE REALLY APPRECIATE THE TIME YOU TOOK TO FILL IN THIS SURVEY. PLEASE REMEMBER TO FILL IN THE PRIZE DRAW CARD TO GO INTO THE DRAW TO WIN $500 WORTH OF MTA VOUCHERS.